AUSTRALIAN MEAT PROCESSOR CORPORATION

Pick pack material handling solution development

Project code:	A.TEC.0117
Prepared by:	Scott Technology Australia
Date Submitted:	December 2014
Date Published:	
Published by:	

Acknowledgement:
The Australian Meat Processor Corporation acknowledges the matching funds provided from the Australian Government, via Meat and Livestock Australia, to support the research and development detailed in this publication.

T (02) 8908 5500 F (02) 9436 0343 E ADMIN@AMPC.COM.AU WWW.AMPC.COM.AU

Executive Summary

Whilst process and machine automation companies, such as Scott Technology, focus on developing sophisticated leading edge deboning automation solutions, packaging companies such as Cryovac, advance vacuum packing machines and plastic films, and robotic automation companies easily provide carton palletising systems in the cold storage area of a processing facility, there is still a significant deficiency with respect to automated solutions within the picking and packing area of an Australian meat processing facility located at the back end of a boning room.

On average there are thirty to forty labour units employed per shift within beef and lamb boning rooms for the sole purpose of filling the void where automation is either not available for picking and packing, to deal with the complexity of the number of stock keeping units (SKUs), and undertake Critical Control Point quality checks, that may ultimately limit full automation from ever being achieved in this area of a Processors business.

Although some of these manually executed tasks can be automated, there is neither a single solution that will radically advance this area of a process or the building blocks existing, and successfully developed, to allow existing solution providers to implement solutions immediately.

Critical Control Point activities such as leak seal detection, parts in a box, correct customer label on a carton or individual piece, are areas within the picking and packing process that arguably should be the last to be automated as a poor result in these activities results in immediate customer dissatisfaction and/or product rejection.

The risks are significant for existing solution providers to alone fill the current void in the pick and pack area due to both the technical risk and each boning room requiring a bespoke tailored solution of common themed unit operations. As such there is the need for the industry to support and strategically develop the required building blocks to progressively enable the advancement of pick and pack automation, commencing with primal identification solutions.

The objectives of the project were to:

- Ascertain where advanced automation and related technology can improve efficiency within the pick and pack process of a lamb and beef boning room.
- Determine where research and development investment is required to realise identified improvements.
- Develop a skeleton research and development road map to enable smart research and development investment strategies.

This study was self-limited to the main areas of picking, packing and handling primals once they leave the boning slicing and trimming area and up to the point where a carton of primals leave the boning area for cold storage (chilling or freezing), due to solutions in other areas of picking and packing (and logistics) within the supply chain being adequately catered for by existing commercial solutions and solution providers.

Within the report, eight unit operations have been identified that could form the basis of a strategic development and investment strategy for the Industry in the area of advanced pick and pack automation. Each unit operation has been detailed to an extent that it could form the basis of a Terms of Reference for a commercial or research company to submit a development proposal on. These unit operations form the basis of the future automated pick and pack process depicted in Figure 1.

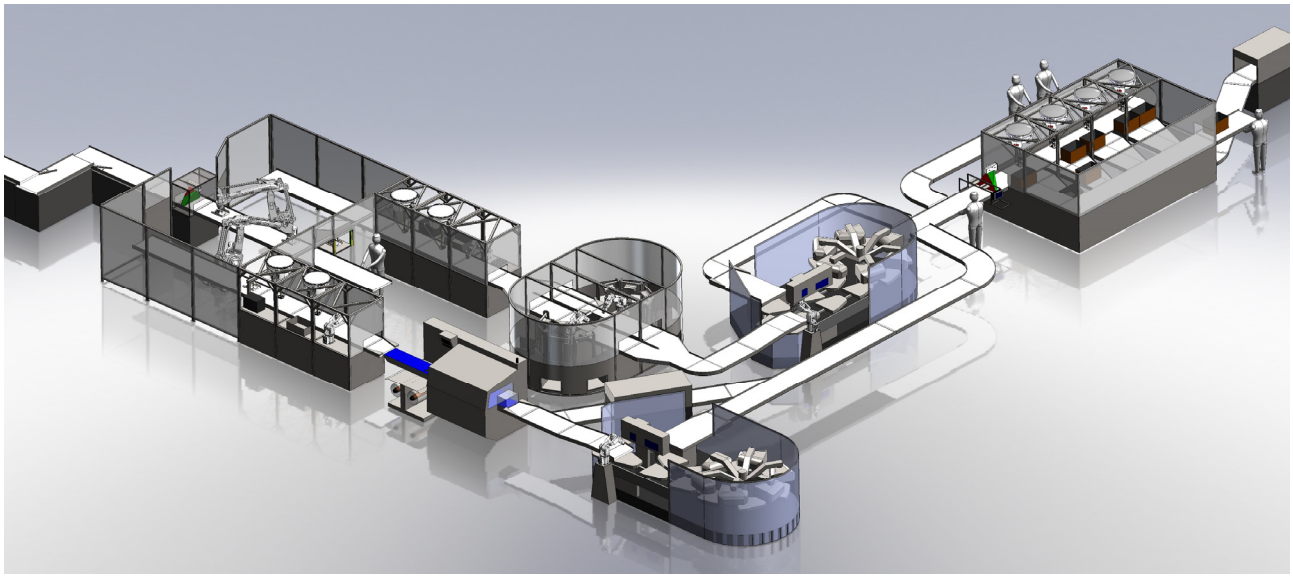


Figure 1: Automated Picking and Packing Concept.

The unit operations where categorised as follows:

- (U01) – Ex-Boning and Slicing Wet Primal Identification
- (U02) – Wet Primal Bagging
- (U03) – Wet Primal Flow Wrapping Placement
- (U04) – Additional Material Application (i.e. Bone guard)
- (U05) – Loading Bagged primals for Vacuuming
- (U06) – Bagged/Wrapped Primal Labelling (and inspection)
- (U07) – Bagged/Wrapped Primal Cartonisation
- (U08) –Cartoned Final Inspection and Labelling

Based on the current Unit Operation concepts the current budget required for undertaking the first demonstration R&D development and indicative resulting recommended retail price for commercially developed solutions are depicted in Table 1.

Table 1: R&D and Commercial Costs.

	R&D (Demo)	RRP (Commercial)
U01	$ 450,000	$ 300,000
U02	$ 600,000	$ 250,000
U03	$ 900,000	$ 650,000
U04	$ 400,000	$ 250,000
U05	$ 550,000	$ 180,000
U06 & 7	$ 1,200,000	$ 700,000
U08	$ 800,000	$ 650,000
Total	**$ 4,900,000**	**$ 2,980,000**

Table 1 has been provided in more detail as a staged (with milestones) R&D investment strategy within the Section titled “Research and Development Strategy”.

It is anticipated that the industry through its collective R&D funding mechanism could develop the R&D demonstrations of each unit operation. Successful demonstrations could then be further developed under Processor Plant Initiated Project funding models (where the host processor obtains the retention of the early development systems). Finally those Processors that wait would be able to obtain the commercial solutions at the above indicative recommended retail prices. In some cases multiple units may be required to match processing capacity.

On the assumption that at least seventy percent of the labour could be removed from the pick and pack area, greater than twenty (20) FTE’s could be placed elsewhere in the business resulting in $2.8 million of investment available based on a two(2) year payback for a processor, operating a single shift.

Contents

Introduction

Once a lamb and beef carcase has been divided into its various components (aka boning and slicing) there are multiple human interactions that are required post the last boner and/or slicer/trimmer and prior to leaving the meat processing facility.

These include:

- Identifying and selecting individual primals from a conveyor belt within a mass of primals.
- Placing a wet primal into a cryovac bag.
- Placing a wet primal onto a singulating feed conveyor of a flow wrapper.
- Inserting or placing bone guard, absorbent pads and other items with primals.
- Placing shrunk/vacuum primals into cartons.
- Quality checking, sealing and labelling cartons.

Each of these activities require operational staff to undertake one or multiple of the following six pick and pack functions:

1. **Identify** - Distinguishes between different products before any other task can be undertaken.
2. **Inspect** - Examines the product for some property.
3. **Handle** - Picks and moves products.
4. **Prepare** - Applying work beyond inspection that does not directly bag or carton a product.
5. **Bag** - Physically placing product into a bag.
6. **Carton** - Physically placing bagged or un-bagged product into a carton.

These functions have been deemed enablers when considering strategic research and development investments in the area of advanced pick and pack technology and automation.

This project has specifically focused on boning room activities and excluded both offal packing (which arguably is similar to boning room packing), trim packing and carton handling and container/truck logistics.

A flow chart of an atypical boning room pack off area is depicted in Figure 2.

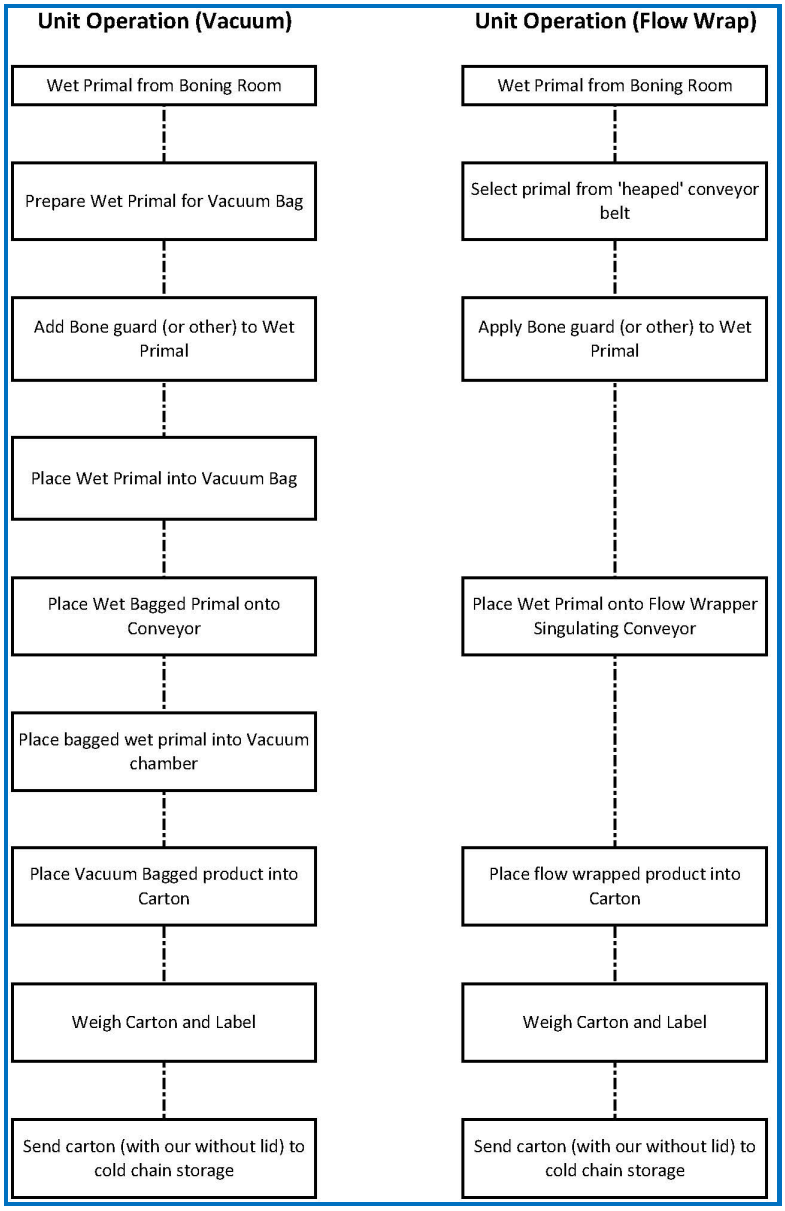


Figure 2: Typical process flow (with operator interaction) for both vacuum packed and flow wrapped primals.

The objectives of the project were to:

- Ascertain where advanced automation and related technology can improve efficiency within the pick and pack process of a lamb and beef boning room.
- Determine where research and development investment is required to realise identified improvements.
- Develop a skeleton research and development road map to enable smart research and development investment strategies.

Methodology

Using an evidence based approach to the research the following best describes the methodology of the project.

EVIDENTUAL DATA COLLECTION & COLLATION
Five site visits conducted to map the layouts and processes, catalogue various packaging machinery/technology and identify labour distribution and functions.

IDENTIFYING FUNCTION TASKS
The function of each labour unit was defined by a set of discrete tasks (E.g. identify, inspect, handle, bag) to identify the quantity and distribution of each task at all sites.

IDENTIFYING OPPORTUNITIES (Collective & Individual)
Given a set cost per labour unit, the expenditure on each function was determined and the potential benefit of varying degrees of automation of each task was calculated.

RESEARCHING AND CONCEPTUALISING SOLUTIONS
The process of researching and conceptualising solutions for each task and function was conducted with the potential for cost benefit as the primary driver.

CONCEPTUALLY AUTOMATING SELECTED PROCESSORS
Various identified solutions were applied (conceptually) to each site to estimate the potential benefit. The results were then amalgamated to inform an industry wide estimate.

Results

Table 1 provides a high level summary of the five sites visited. To accommodate for different processing throughputs the full time equivalents (FTEs) were normalised on a 40,000 head per week of lamb (or 9 carcases/min) and 8,000 head per week beef (or 105 head/hr) processing capacity. It is this normalised data that was then used for comparison throughout the remainder of the report (unless otherwise specified).

Table 2: High level summary of five sites investigated.

Species	Lamb	Beef
FTE's in P&P activities (indicative)	26-38	34-44
% FTE's in P&P area	13-18	9-10

With current manual labour employment levels in picking and packing activities that represent typical daily absenteeism levels at most processing sites, automation of some of the remaining manual pick and pack areas also has a possible opportunity to reduce the impact of absenteeism on a daily basis.

Process FTE by Function

Processor studies resulted in identifying six picking and packing functions of FTEs. Table 2 depicts how the spread of functions is utilised within each of the five processing facilities. Any and all tasks which require either Identify or Inspect are functions are included in the values given below. Regarding Handle, Prepare, Bag and Carton, each of these tasks has been considered to be mutually exclusive, that is, even though a cartoner will handle product, the task is only registered once in the table below in this case as a Carton task.

Table 3: Picking and Packing functions across the five sites.

	Lamb	Beef
Identify	77-95%	82-86%
Inspect	88-95%	82-93%
Handle	11-19%	12-35%
Prepare and Bag	31-51%	12-61%
Carton	36-50%	27-53%

Independent of which plant was investigated the distribution of activities of staff were relatively similar. This indicates that a whole of industry strategic development program could benefit both beef

and lamb processors alike. The only significant difference was seen between two beef facilities where one company had installed recent flow wrapping technology. Although the flow wrapping technology reduced staff in one application the reduction of staff was then significantly place in lead up pick and pack processing.

Time in Motion Study by Task & Function

Time in motion studies of the activities (and later to be defined unit operations) were undertaken to allow those that follow this document with respect to research and development to understand the cycle times required for various activities and hence pending solutions.

Table 4: Pick and Pack activities tact time.

Task	Beef (secs)	Lamb (secs)
Locate, pick and place primal from belt to table/rack/belt.	1 - 2	1 - 2
Secure product from belt, select bag and place single primal into bag and return to conveyor.	3 - 10	3 - 5
Apply sticker or drip pad.	1 - 5	1 - 5
Apply bone guard wrap, sticker and drip pad (Eg. Racks).	10	15
Pick, place and align vacuum bag on vacuum chamber plate and seal bar (fastest observed / Average observed).	2.3 - 4.3	2.7 - 3.0
Pick and place primal on flow wrapper singulator feed conveyor.	Limited by flow-wrap machine .	
Identify, pick and pack primal into carton.	3.5 - 5	3.5 - 5
Identify carton contents, weigh and apply carton label.	10-20	10-20

Additional detail from time in motion study:

- Bagging a single medium sized bone in primal (Racks, using a bag opener) takes on average 3 seconds.
- Bagging a large bone in Primal (Shoulder Square cut) was estimated at 15 seconds.
- Bagging multiple small boneless primals (Tenderloins, 4 products per bag, no drip pads used, sticker applied to inside of bag) takes on average 54 seconds.

Packaging Materials

Each of the five processing sites had a varying range of plastic bags, wraps and cardboard cartons as depicted in Table 5. This table must be considered when developing any strategic program to develop advanced pick and pack automation.

Table 5: Packaging material matrix.

	Lamb	Beef
Carton Size Specifications (Qty.)	8 base variants	6 base variants
Plastic Wrap Specifications (Qty.)	2 for 'no bagging' and 1 prior to bagging	Up to 2 for flow wrapping if done
Plastic bag Variants	21	6 for primals, 6 for offal and other
Maximum Carton Size (L x W x H)	570mm x 340mm x 330mm	548mm x 317mm x 207mm
Minimum Carton Size (L X W X H)	550mm x 340mm x 140mm	410mm x 270mm x 115mm
Bone in Roll Rap (L x W)	280mm - 450mm	N/A
Maximum Bag Size (L x W x H)	360mm x 460mm	500 mm x 800 mm
Minimum Bag Size (L x W x H)	275 mm x 700mm	300 mm x 600 mm

Primals and Stock Keeping Units (SKUs)

Historically a significant hurdle to Pick and Pack Automation has been the large quantity and continually increasing number of Stock Keeping Units (SKUs) that processors currently have and their marketing departments continue to generate. In addition the requirement of items such as bonegiard ad trip pads based on customers rather than product item adds to both the automation complexity and the number of SKUs. Understanding the quantity of SKUs is important for any automation Pick and Pack automation strategy as each SKU may have a different bag, wrap, carton, bone guard, label, trim specification as examples. The number of SKUs per process is depicted in **Error! Reference source not found.**.

Table 6: SKUs by Processor.

	Indicative Lamb	Indicative Beef
Primals (Qty.)	85	88
Stock Keeping Units (Qty.)	300-500	300-500

An example of some of the issues that the various SKUs present to automation is depicted in Figure 3. These depiction also show the complication boneguard and other inserts introduce to automating the pick and pack operation.

Figure 3: Various product presentation that automation must cater for (extracted from the Greenleaf report).

Although there are a limited number of primal specifications (compared to overall SKU count) that can be produced from both a beef and lamb carcase the number of primals, the never ending possible combinations of varying trim specifications and sizes and colour vex automated inspection systems.

Host Processor Equipment

The Australian processing sector acquires its current solutions from the following four companies, with the first three being the predominant suppliers:

- Cryovac (http://www.cryovac.com/)
- Ulma (http://www.ulmapackaging.com/)
- Multivac (http://www.multivac.com.au/)
- Supervac (http://www.supervac.at/en)

In addition to the above there are a plethora of companies offering similar equipment, especially a large number emerging from China and India. These companies have not been considered further in this report as they appear to offer nothing in addition to the above four.

Throughout the five processor visits and other processing location knowledge from within the Scott Group, most processors all utilise common pick and pack solution providers and methods. Where the equipment in use has been in use for many years it is relatively robust and reliable with areas for only slight efficiency improvements remaining.

One company in the group of five had attempted a more automated bagging primal concept, i.e. reduce the labour units required for placing wet primals into bags/wraps. This attempt provided an improvement on FTE use, however fell short of the expected realisation of FTE efficiency improvements. Two other companies not within the group of five, but known by Scott through other visitations, has also attempted to automatically bag primals (using robots, both a beef and lamb system), again with the result falling short of the original expected outcome, especially for the beef processor The lamb system was a lot closer to the expletive objective being realised. In these case circa 60-90% FTE efficiency KPI was obtained however at the cost of increase plastic use/waste.

All of this indicates that the existing solution providers in the pick and pack area of the business, whilst providing very robust picking and packing solutions in their own rights, are all providing much the same solutions. None are more commercially advanced than the others in any significant way with respect to full automation, some have provided work in progress evidence of advanced pick and pack automation, but none to date have a commercially viable solution(s) that is being adopted by the entire industry, to fill in the remaining non-automated pick and pack areas.

Existing Solutions and Supplier Options

Tables 6-9 inclusive provides a summary of typical systems in industry under the headings of:

- Bag Loaders, Dispensers and Flow Wrappers
- Vacuum Chamber Machines
- Auto/Robotic Tray Loaders
- Auto Printing and Labelling *(Note – all case ready solutions)*

Of note is that companies such as ABB also promote robotic case picking solutions, however they are all similar to the ones identified as being offered by the majour four suppliers as the majour four suppliers use off the shelf ABB (and others) robots.

The 'Processor' column signifies which of the existing four solution companies systems where in use by each of the five host Processors.

Table 7: Bag Loaders, Dispensers and Flow Wrappers Commercially Offered.

Bag Loaders/Dispensers & Flow Wrappers							
Product Name	Company	Man. Auto.	Application	No. of Bags	Bag Width (mm)	Capacity (pks/min)	Processor 1 2 3 4 5
BLR1 RoboLoaders™	Cryovac	Auto.	Wet Primals	2-6	225-450	15-20	
BLR2 RoboLoaders™	Cryovac	Auto.	Wet Primals	2-6	225-450	15-20	
Taped Bag Loadinging Machinery	Cryovac	Man.	Wet Primals	1-2	<400	15	
BL101 Auto Bag Loader (Horizontal)	Cryovac	Auto.	Wet Primals	1	<375	17	
BL125 Auto Bag Loader (Vertical)	Cryovac	Auto.	Wet Primals	1	175-225	20	
BL126 Auto Bag Loader (Vertical)	Cryovac	Auto.	Wet Primals	1	250-350	20	
8800E Rot. Vac Chamber + Bag Loader	Cryovac	Auto.	Wet Primals	2	225-350	15	
FM300 Flow Pack Wrapper	Ulma	Auto.	Wet Primals				
FV35 Flow ack Wrapper (HFFS)	Ulma	Auto.	Wet Primals	1			1
FV55 Flow ack Wrapper (HFFS)	Ulma	Auto.	Wet Primals	1			4
Optima	Ulma	Auto.	Wet Primals				
BG450 - Bag Opening Machine	Supervac	Auto.	Wet Primals	1		40	

Table 8: Vacuum Chamber Systems Commercially Available.

Vacuum Chambers							
Product Name	Company	Man. Auto.	Application		Seal Bar Length (mm)	Capacity (pks/min)	Processor 1 2 3 4 5
V Series Vacuum Chamber	Cryovac	Semi	Bagged Primals		900-1500	1.5-3.3**	
8600 Series Rotary Vacuum Chamber	Cryovac	Auto	Bagged Primals		300-450	10-60	2 2 3 2 3
8800E Rot. Vac Chamber + Bag Loader	Cryovac	Auto.	Wet Primals	2	225-350	15	
Darfresh® Vacuum Skin Packaging	Cryovac	Auto	Wet Primals	3		10-40	
B210 Conveyor Belt Vacuum Machine	Multivac	Auto	Bagged Primals		800-1150		
B310 Conveyor Belt Vacuum Machine	Multivac	Auto	Bagged Primals		2 x 950		
B510 Conveyor Belt Vacuum Machine	Multivac	Auto	Bagged Primals		2 x 1300		
B610 Conveyor Belt Vacuum Machine	Multivac		Bagged Primals		2 x 1500		
C400 Single Chamber Machine	Multivac	Semi	Bagged Primals		450 & 650		
C700 Single Chamber Machine	Multivac	Semi	Bagged Primals		various		
C800 Single Chamber Machine	Multivac	Semi	Bagged Primals		2 x 780		
C450 Double Chamber Swing Lids	Multivac	Semi	Bagged Primals		2 x 450		
C500 Double Chamber Swing Lids	Multivac	Semi	Bagged Primals		2 x 650		
C550 Double Chamber Swing Lids	Multivac	Semi	Bagged Primals		2 x 850		
GK250 / 260 Vacuum Chamber	Supervac	Semi	Bagged Primals		4 x 455-460		
GK289 / 290 Vacuum Chamber	Supervac	Semi	Bagged Primals		4 x 650		
GK195 Belt Vacuum Chamber	Supervac	Auto	Bagged Primals		2 x 1000		
GK169 / 170 Belt Vacuum Chamber	Supervac	Auto	Bagged Primals		2 x 660		
GK 402 / 403 Belt Vacuum Chamber	Supervac	Auto	Bagged Primals		2 x 800		
GK652 (+3) Belt Vacuum Chamber	Supervac	Auto	Bagged Primals		2 x 1100		
GK852 (+3) Belt Vacuum Chamber	Supervac	Auto	Bagged Primals		2 x 1300		

Table 9: Automated & Robotic Tray Loading Solutions Commercially Available (Note: all single product/primal case ready solutions).

Auto/Robotic Tray Loaders						
Product Name	**Company**	**Man. Auto.**	**Application**	**Product Weight (kg)**	**Capacity Cycle Time (cycle/min)**	Processor 1 2 3 4 5
H050 Robotic Prefeed Singulator	Multivac	Auto	Single Primal	2	45	
H100 Robotic Product Loader	Multivac	Auto	Single Primal	5	50	
H130 Robotic Product Loader	Multivac	Auto	Single Primal	1-10**	50-100**	
H240 Robotic Product Loader	Multivac	Auto	Single Primal	1	240	

Table 10: Automated Printing Systems Commercially Available.

Auto Printing & Labelling (All Case Ready)						
Product Name	**Company**	**Man. Auto.**	**Application**	**Product Weight (kg)**	**Capacity Cycle Time (cycle/min)**	Processor 1 2 3 4 5
MR625 OP - Pack Top Labelling	Multivac	Auto	Case Ready		75	
MR615 EF - Web Labelling	Multivac	Auto	Case Ready		75	
MR635 UP - Bottom Labelling	Multivac	Auto	Case Ready		75	
MR645 OU - Above/Below Labelling	Multivac	Auto	Case Ready		75	
MR292 TT - Dreict Web Printing**	Multivac	Auto	Case Ready			
MR296 IK - Ink Printing**	Multivac	Auto	Case Ready			

Tables 6 to 9 inclusive demonstrate that:

1. There is a very limited range of commercially viable system to reliably place wet primals into bags.
    a. The flow wrapper concept appears to be the most widely chosen method. This method does not use any robotic method to handle the primal or the plastic.
    b. The robot method (utilised by two Australian processors) uses a robot to place the bag on the primal. The beef company deplores the concept whereas the lamb company supports the installation.
    c. No system has been designed on placing the primal into a bag (i.e. the robot handles the meat).

2. Most of the current commercial Pick and Pack automated solutions (especially those used in 'retail ready' and/or smallgoods operations) are designed for a line with the same product (i.e. hamburgers and hence looking for a part but does not care what the part is) and product size (i.e. gripper can be of a single part size design).

   a. Systems are not currently available to pick from a conveyor with a mix of all possible primals being conveyed along a belt (i.e. the current range of flex picker robotic solutions commercially available).

3. There is no commercially offered bag insertion systems available.
   a. Prototype example videos have been located on YouTube for non-wet meat applications.

4. There are no commercially offered inline bag printing or labelling systems that can survive the cryovac and/or flow wrapping process.
   a. All of the labelling systems are either for the film on case ready trays, or paper labels which are then placed on a primal after either shrink or vacuum packed.

5. There are no unique wet primal identification systems commercially on offer.
   a. That is systems that can differentiate a striploin from a cube roll.

Discussion

As identified in the Greenleaf report A.TEC.0093 – Picking, Packing and Materials Handling Review, the concerns that are always presented by processors as a reason not to automate in a substantial way the areas of Pick and Pack include:

- Speed at which primals can be cartoned (or bagged).
- The number of products which can be packed using the same piece of equipment. (flex picker).
- Production inspection requirements (specification, quality and process verification).
- Requirements for carton and/or bagged product insert and other unique customer requirements (i.e. bone guard, absorbent pads).
- Design of existing room to allow automation installation.

Additional considerations from a Scott perspective, as an automation company include:

- It is generally cost prohibitive to develop a solution than can automate a task 100%. Even in within the advanced Scott automated boning room lamb cutting systems (LEAP), Scott systems are not designed to process ANZACs (one legged animals or animals with removed rib cages via excessive trimming). It is cost prohibitive for the Scott system to be designed for this last nominal 1% of carcases and this point is accepted by meat processing companies.
- A task needs to be fully understood before it should (and can be automated), for example the sealing area on a Cryovac bag must be 'meat grease' free for an effective seal.
- There are many companies who can demonstrate a single concept approach working (i.e. case ready robotic flex picking of a product at rapid speed), however they do not understand the limitations of a single part end effector and single part vision system when applied to the back end of a meat processing facility (that is not case ready).

There is an age old philosophy in automation that once you have hold of a part never let it go. This is also true and mandatory in the areas of Pick and Pack automation. However, in this day and age, this rule can be complied with in other ways such as by using exact conveyer belt primal positioning and systems such as RFID or label tracking and inspection system.

The main rule that must be remembered, and hence not violated, in the area of Pick and Pack automation is that early in the process a primal needs to be identified and identification retained to enable downstream automation to be effective and that automation needs to accommodate a large range of varying product shapes and sizes.

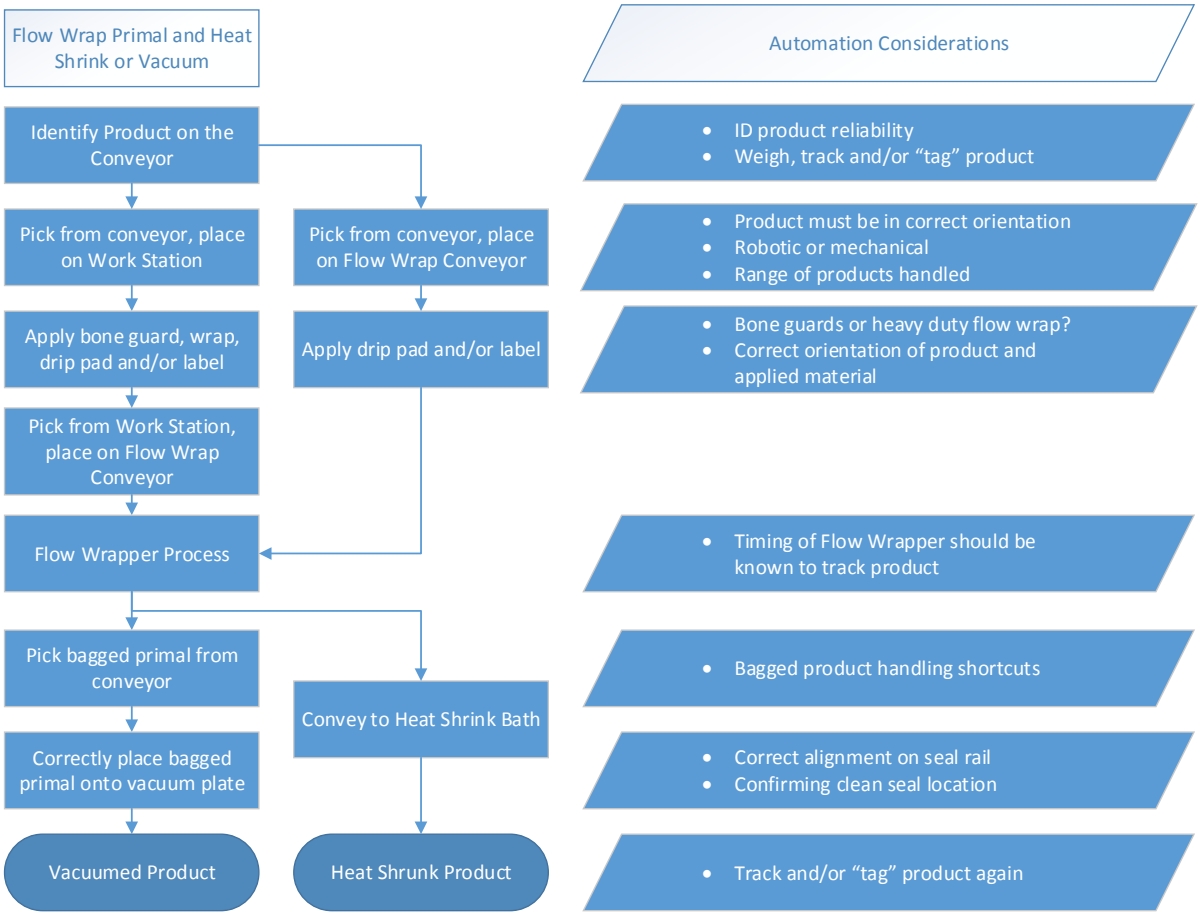
Solution Research and Development

Understanding the current process flow and activities is key to developing a strategic advanced automation research, development and demonstration strategy via ascertaining the key automation enablers.

For both the process of producing vacuum packed (i.e. via a Cryovac) and a heat shrunk flow wrapped resulting product, the current human process is depicted in the following flowcharts. Each flowchart identifies the main unit operations within the pick and pack process, followed by the activities that are undertaken by operational staff. Having ascertained the activities undertaken it is possible to then understand what the enablers are to result in automation of the task.

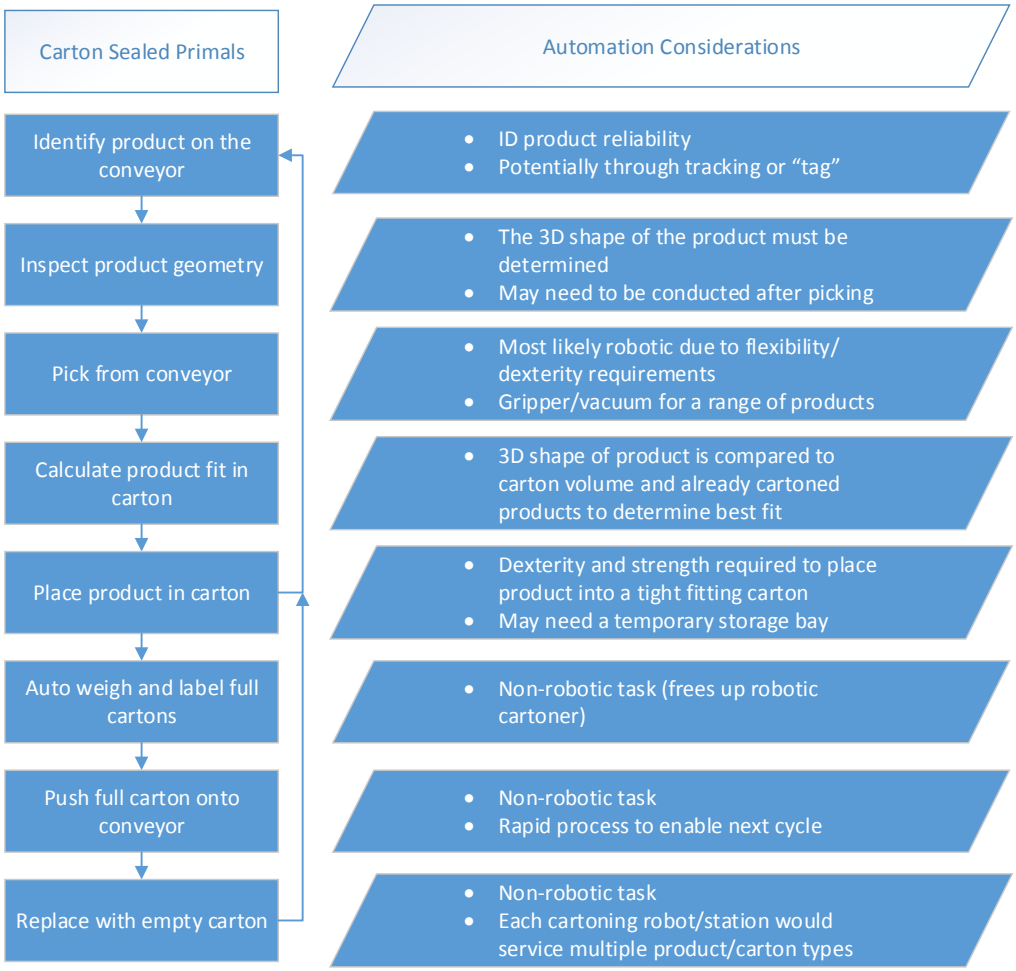
These automation enablers can then be used to inform the development of a strategic research, development and demonstration program.

Automation Enablers – Flow Wrapped Primals



Automation Enablers – Vacuum Primals

Automation Enablers – Wrapped/Vacuum Primals into Cartons



Advanced Automation Research Areas

Utlising the previous three flow charts, there are eight distinct areas (or unit operations) of the process that theoretically could be automated. All have a combination of unique and overlapping technical platform enablers and arguably some require automation before effective automation of other tasks is achievable the potential areas of advanced automation research have been broken into the following eight unit operation categories:

1. Ex-boning and slicing Wet Primal Identification.
2. Wet Primal bagging
3. Wet Primal Flow Wrapping Placement.
4. Additional material application (i.e. Boneguard, absorbent pads, etc.)
5. Wet Primal Vacuum Bagged machine loading.
6. Bagged/Wrapped Primal Intermediate Labelling (and inspection).
7. Wrapped/Bagged Primal Cartonisation.
8. Cartoned Product Final Inspection and Labelling.

Concept Demonstrations

An internet review provides examples, that although not fit for purpose for red meat packing (i.e. not case ready packing), identify different approaches and thinking for research and development concepts for advanced automated red meat boning room pick and packing.

Table 11: Available internet concepts for further research and development consideration.

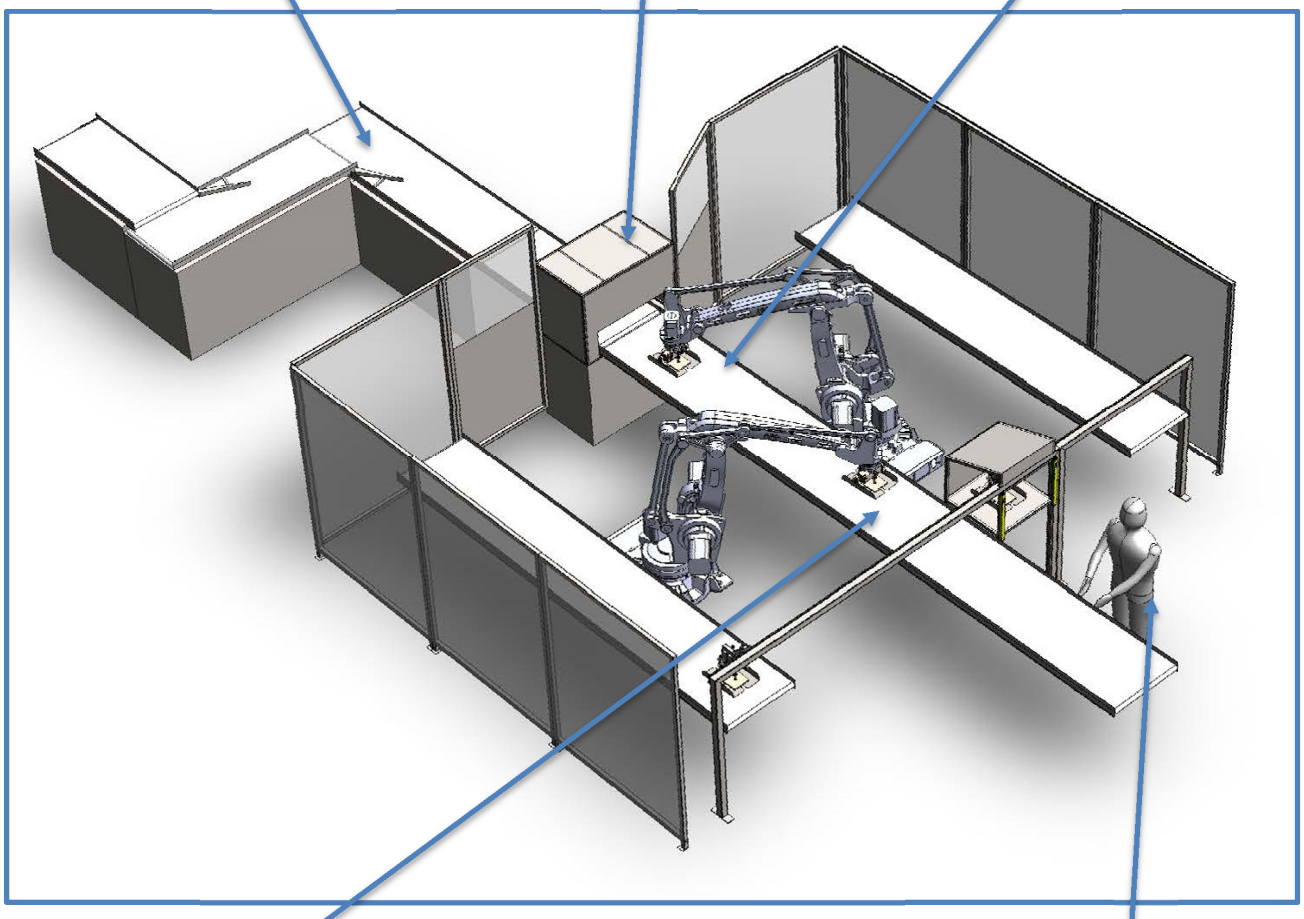
Outcome	Video Link
Auto stuffing/placing cured meat into Cryovac bags.	https://www.youtube.com/watch?v=mUc6pte_Zns
Auto feeding flow wrapper with wet primals and absorbent pad.	https://www.youtube.com/watch?v=2P9eL7bnV9Y
Auto vacuum bag stuffing and auto feeding into a Cryovac machine	https://www.youtube.com/watch?v=igiY9M4euXs
Automated portion loading into case ready trays (single product only).	https://www.youtube.com/watch?v=_X2baoH_7M0
Automated flow wrapping machine feeding with underneath sealing.	https://www.youtube.com/watch?v=y_fqoFoI1ss
Singe portion meat end effector gripper	https://www.youtube.com/watch?v=qfUR4jz6fFY
Rapid flexible robotic picking, all the same part, however non-uniform distribution on conveyor belt.	https://www.youtube.com/watch?v=aPTd8XDZOEk
Rapid packing of uniform meat pack sizes into cartons.	https://www.youtube.com/watch?v=a7XzTTEaiuU
Case ready auto loading using conveyor belt rather than a robot.	https://www.youtube.com/watch?v=zWlgSfSxvJo
Flex picking robot gripper same meat part with varying thicknesses.	https://www.youtube.com/watch?v=7H_IFe0NNr4
Auto grabbing and opening Cryovac bags, filling (with liquid in the vertical orientation) and sealing.	https://www.youtube.com/watch?v=sg1mzJxOh8E
Automatically picking and placing absorbent pads.	https://www.youtube.com/watch?v=7DAO9Hp65SI
Single picking from a box of loosely pack items.	https://www.youtube.com/watch?v=3CQQDBSbS3o
Auto cryovac bag opening, inserting absorbent pad and then wet primals.	https://www.youtube.com/watch?v=YxSjndwnUsA
Auto ink jet printing on an auto opening bag systems.	https://www.youtube.com/watch?v=gcZy2VPRrCw
Over printer on case ready meat.	https://www.youtube.com/watch?v=KRYOgf25le4

Strategic Research and Development Areas

Each of the following identifies a unique unit operation that requires further development, the measures of success and points for consideration during development.

Unit Operation 1: Ex-Boning and Slicing Wet Primal Identification

Objective
To ensure that 100% of all primals leaving the last boning/slicing activity are identified as to the primal that they are (and ideally the customer order/specification they have been produced for).
Human Activities / Actions Required
Although an FTE does not undertake this task in isolation, it is required for almost all other Unit Operations within the Pick and Pack process. A strategic approach to Pick and Pack automation will require a method (or methods) to enable primal identification to be undertaken and provide one of the majour inputs into automation most (if not all other) Pick and Pack unit operation automation.
Product Considerations
Shape, size, weight, meat:fat:bone ratios and colour, orientation (including upside down). How many primals, sub-primals and primal specs are there? Is lamb and beef different?
Processing Considerations
Speed, overlapping product on a belt, folded over product, belt colour, environment (lighting. What happens if people bypassing the system. What happens if a primal is not automatically identified?
Automation Considerations
What percentage of all primals can be identified (i.e. 18 out of 25)? What percentage of a specific primal can be identified all the time (i.e. 9 times out of 10 a cube roll is identified)? How many primals are identified as an incorrect primal (i.e. a cube roll is identified as a striploin).
Suggesting R&D Demonstration and Development Approach
1. Starting with a basic Vision Camera system how many primals can be seen in all of their weigh ranges, sizes, colours, orientations? 2. For those that cannot be seen, or confused with others, what are the next levels of Smart Sensing and Visioning that can increase the hit rate (i.e. scales, 3D profiling, x-ray, ultrasound, side primal counts)? 3. Develop an understanding of the above and demonstrate in-situ to a suitable level that will support the development being used as the basis of a future commercial solution.
Processor automation concerns (Direct feedback from Processor interviews)
- How does developing a solution in this area enable advanced automated pick and pack solutions? - Will I loose flexibility if the system is not available to do all the current/future primal mixes? - Concerned with quality control. For example, leg damage from boning.
Ultimate R&D Question(s) to be Answered
What are the costs of a reliable primal identification system and an automation enabler?
How is this development used in an Advanced Automated Pick and Pack Operation
Each primal will/may require: - A special wrap applied to it, boneguard or other insert. This is currently undertaken by an operator. - A product identification customer label, which is currently manually identified, coded and applied.
Preceding Research
- None


Primal identification scanning 'black box'
Intermediate product singulating conveyors
Non-flow wrapped primal pick and place
Flow wrapped primal pick and place
Human '10%' primal identification failure rectification

Unit Operation 2: Wet Primal Bagging

Objective

Place a wet primal into a bag or plastic film (for flow wrapping).

Human Activities / Actions Required

After an FTE has grasped a primal, they will ensure that the primal should be on the conveyor belt that they have procured it from (hence should it be wrapped/bagged by them), they may undertake an inspection process (if required, trained and/or diligent) then they will determine which bag and/or wrap to place it into (if their station has a choice of bag type/sizes and/or wrap type/size). They may also place bone guard, as soaker pad or other product and/or customer specification requirement. The wet primal will leave this unit operation with a form of plastic wrap and/or bag around it.

Product Considerations

The same primal can be:

- A different size (length, shape, etc.) depending on carcase size and trim specification.
- A slightly different shape depending on carcase size and trim specification.
- Primal could be in any orientation and hence could appear different to an inspection system.
- A primal could have a different weight depending on the original carcase weight and trim specification.

Questions/Points

- What happens if a primal has been excessively trimmed and does not look like what the automated inspection system has been 'trained' to look for (probably send it to the '10%' pack line).

Processing Considerations

- Ensure that the product does not touch and plastic surface that will be a seal face (otherwise seal will be ineffective and result in a 'leaker'.

Automation Considerations

- Will one gripper solution work for all primals? (Probably not)
- What is the trade-off matrix of number of grippers vs throughput vs primals handled?

Suggesting R&D Demonstration and Development Approach

- Stage 1 - Develop a range of grippers (with a simple 3D inspection system) and associated product presentation 'conveyor' that can demonstrate to processors a system working in a meat processing facility. The system would be installed and operate real time and show all primals effectively being picked up and placed back onto a belt.

Processor automation concerns (Direct feedback from Processor interviews)

- Some products will require bone guard
- Some products will require an absorption pad
- Achieving the correct orientation and presentation is also important.

Ultimate R&D Question/Point(s) to be Answered/Addressed

- What inspection system (i.e. vision and/or sensing) can be used to ascertain a primal identification system that is vital to enable Pick and Pack automation to occur?
- There may be a cost vs effectiveness consideration. Hence the silver bullet might be cost prohibitive for some or all processors whereas the non-silver bullet approach might only be 90% effective.

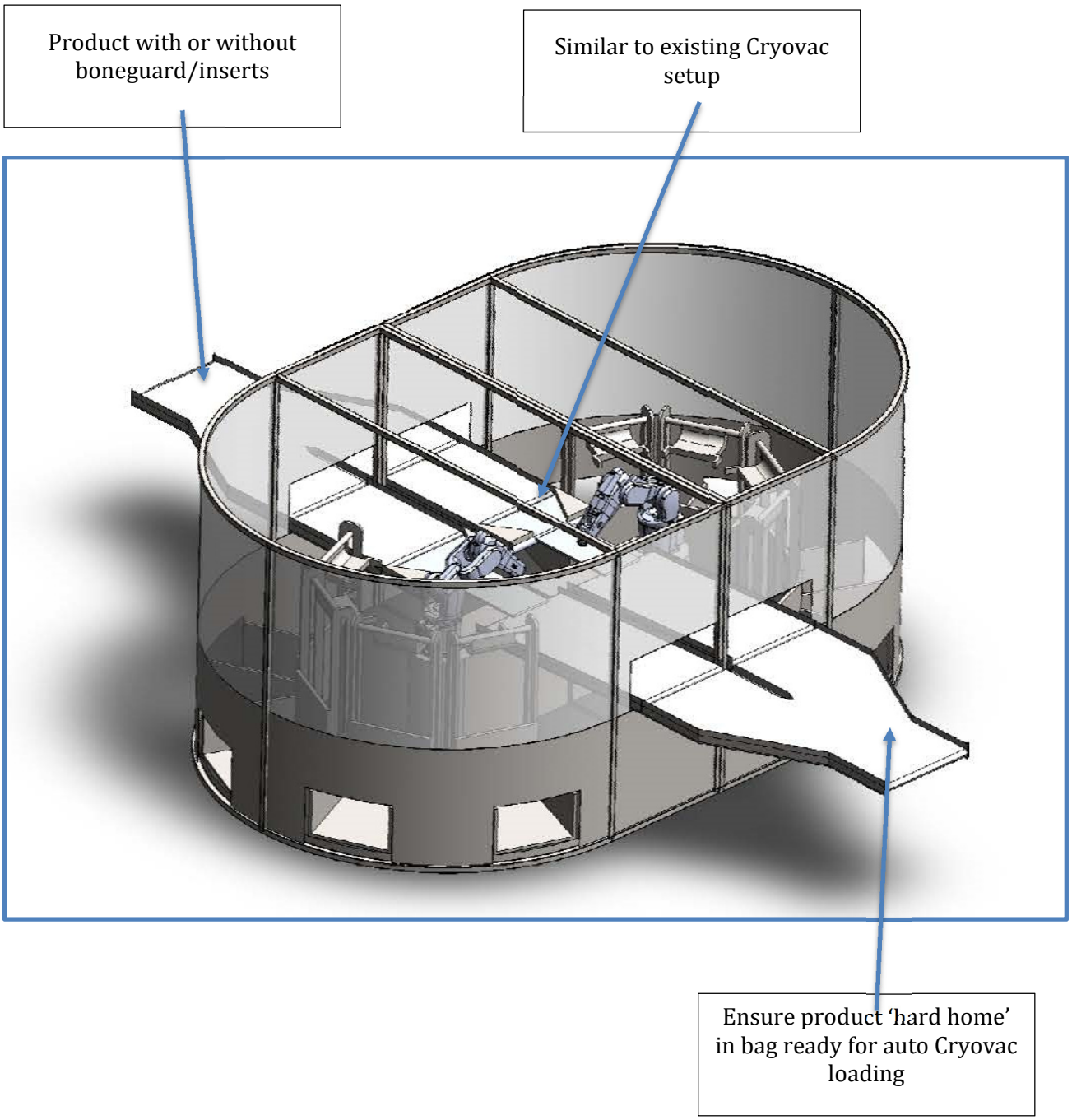
How is this development used in an Advanced Automated Pick and Pack Operation

Currently there does not appear to be a viable commercial solution for placing:

- Placing primals into vacuum bags or vacuum bags onto primals.

Preceding Research

- Unit Operation 1 and Unit Operation 5 (deepening upon application). Ideally Unit Operation 4.


Product with or without boneguard/inserts
Similar to existing Cryovac setup
Ensure product 'hard home' in bag ready for auto Cryovac loading

Unit Operation 3: Wet Primal Flow Wrapping Placement

Objective

Place a wet primal (from a loose meat conveyor) onto a singulating conveyor (for flow wrapping).

Human Activities / Actions Required

After an FTE has grasped a primal, they will ensure that the primal should be on the conveyor belt that they have procured it from (hence should it be wrapped/bagged by them), they may undertake an inspection process (if required, trained and/or diligent) then they will determine which bag and/or wrap to place it into (if their station has a choice of bag type/sizes and/or wrap type/size). They may also place bone guard, as soaker pad or other product and/or customer specification requirement. The wet primal will leave this unit operation with a form of plastic wrap and/or bag around it.

Product Considerations

The same primal can be:

- A different size (length, shape, etc.) depending on carcase size and trim specification.
- A slightly different shape depending on carcase size and trim specification.
- Primal could be in any orientation and hence could appear different to an inspection system.
- A primal could have a different weight depending on the original carcase weight and trim specification.

Questions/Points

- What happens if a primal has been excessively trimmed and does not look like what the automated inspection system has been 'trained' to look for (probably send it to the '10%' pack line).

Processing Considerations

- Ensure that the product does not touch and plastic surface that will be a seal face (otherwise seal will be ineffective and result in a 'leaker'. Hence requires centre of film placement.

Automation Considerations

- Will one gripper solution work for all primals? (Probably not)
- What is the trade-off matrix of number of grippers vs throughput vs primals handled?
- Probably a different gripped to the Unit Operation 2 gripper.

Suggesting R&D Demonstration and Development Approach

- Stage 1 - Develop a range of grippers (with a simple 3D inspection system) and associated product presentation 'conveyor' that can demonstrate to processors a system working in a meat processing facility. The system would be installed and operate real time and show all primals effectively being picked up and placed back onto a belt.

Processor automation concerns (Direct feedback from Processor interviews)

- Some products will require bone guard
- Some products will require an absorption pad
- Orientation is critical for correct flow wrapping

Ultimate R&D Question/Point(s) to be Answered/Addressed

- What inspection system (i.e. vision and/or sensing) can be used to ascertain a primal identification system that is vital to enable Pick and Pack automation to occur?
- There may be a cost vs effectiveness consideration. Hence the silver bullet might be cost prohibitive for some or all processors whereas the non-silver bullet approach might only be 90% effective.

How is this development used in an Advanced Automated Pick and Pack Operation

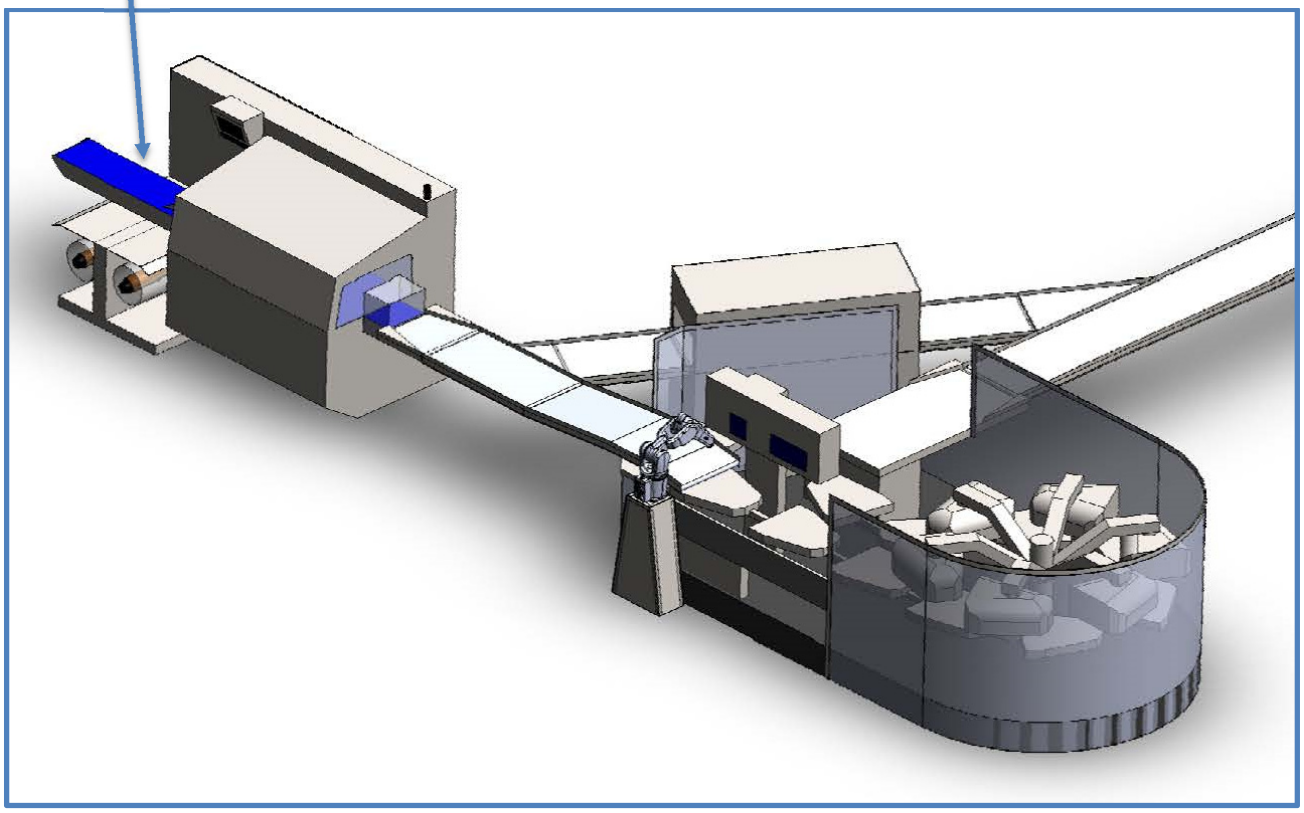
Currently there does not appear to be a viable commercial solution for placing:

- Placing primals onto the singulating feed conveyor of a flow wrapper.

Preceding Research

- Unit Operation 1 and Unit Operation (deepening upon application). Ideally Unit Operation 4.

Auto flowrapper primal placement (with or without boneguard/inserts)

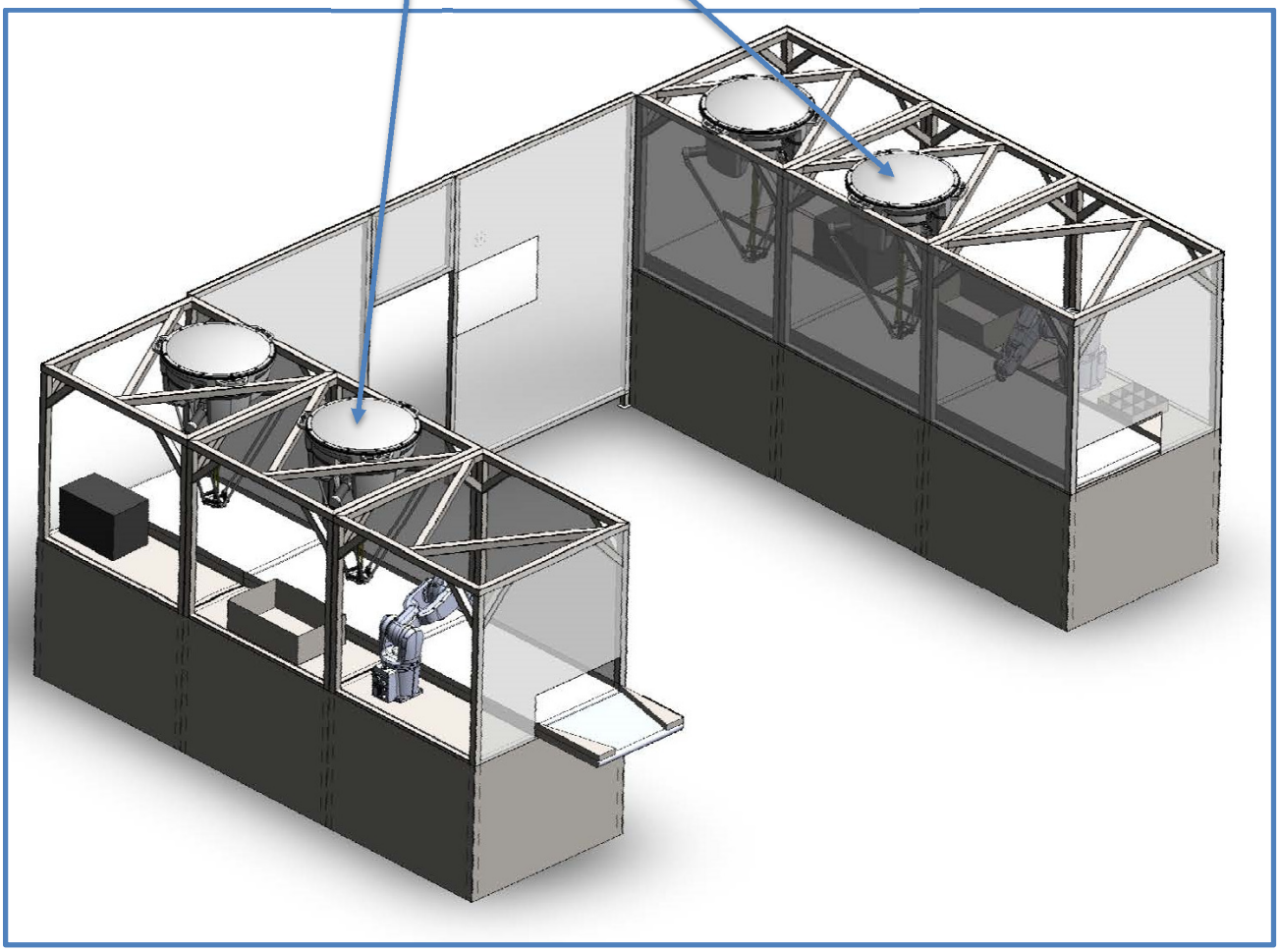


Unit Operation 4: Additional Material Application (i.e. Bone guard)

Objective
Some primals due to issues such as sharp bone or weep, or customers, required/demand that additional items are included with the bagged/wrapped primal. How are these automatically applied?
Human Activities / Actions Required
- After an operator has placed a primal onto a singulating flow wrapper feed conveyor they may also place an absorbent pad to the top of the primal. - After an operator has placed a primal into a vacuum bag they may also place an absorbent pad into the bag. - An operator may wrapped bone guard around a product prior to placing it into a vacuum bag or onto a flow wrapper singulating feed conveyor. - An operator may be required to place a paper ticker or other customer insert into a vacuum bag with a primal or on the top of a primal after it is placed onto the feed singulating conveyor of a flow wrapper.
Product Considerations
- .
Processing Considerations
- Not all primal needs this application. Can this process be removed from early pick and pack automation concepts?
Automation Considerations
- Need a system to feed the inserts to the automated insertion/application solution. - How do you wrap bone guard around primals?
Suggesting R&D Demonstration and Development Approach
Three different solutions are required: - Boneguard wrapping - Absorbent pad primal placement (flow wrapping) and insertion (vacuum bag) - Ticket (or other) primal placement (flow wrapping) and insertion (vacuum bag)
Processor automation concerns (Direct feedback from Processor interviews)
- How can a solution that is not used all the time be commercially justified? - What happens if we change insertion material specifications and/or add to them?
Ultimate R&D Question(s) to be Answered
- What does a process look like that does not have this step automated (i.e. is it commercially viable and necessary)? - Is a post application inspection system required for validation?
How is this development used in an Advanced Automated Pick and Pack Operation
If the person(s) who currently pick and pack also apply these additional items, then automating the pick and pack activities will not reduce the labour required if the same labour content remains to undertake this additional activity.
Preceding Research
Unit Operation 1. Arguably Unit Operations 2 & 3.

T (02) 8908 5500 F (02) 9436 0343 E ADMIN@AMPC.COM.AU WWW.AMPC.COM.AU

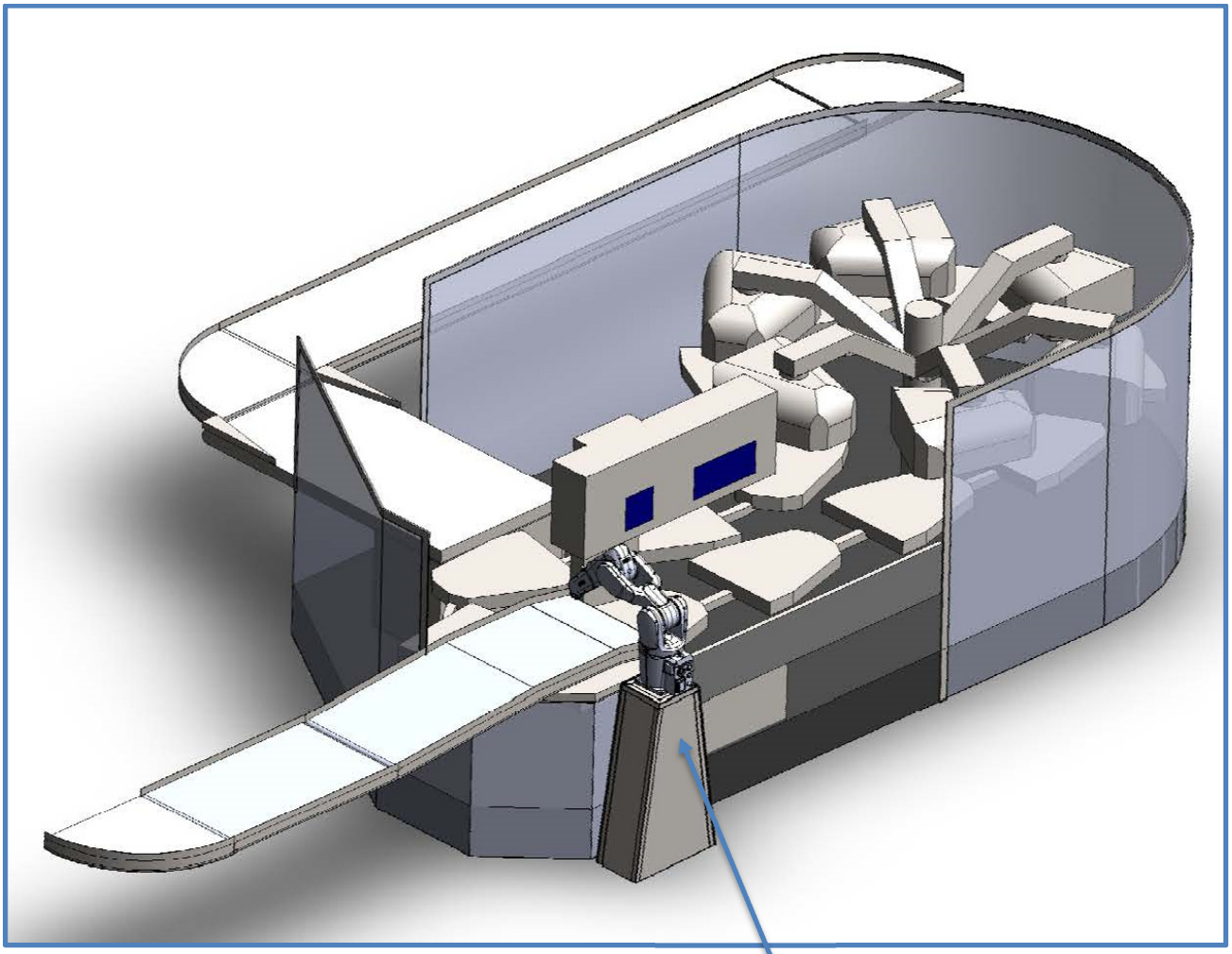
Various 'robotic' cells for placing boneguard/inserts



Unit Operation 5: Loading Bagged primals for Vacuuming

Objective
Pick and Place a bagged or wrapped Primal into a Vacuum machine in the correct orientation.
Human Activities / Actions Required
- Identifies desired seal location on the bag, inspects bag for contamination that would result in bad seal. - Picks bagged product from a conveyor, products may be presented singulated or in uncontrolled batches/heaps. - Reorientates and places the bagged product to allow correct alignment of desired sealing location. - Temporarily stores or banks up products when no space on the vacuum machine is available.
Product Considerations
- Variability of product and bag sizes, tightness and orientation. - Cleanliness of bag exterior that would affect handling characteristics. - Product cadence and arrangement (w.r.t. other products) on presentation to this station.
Processing Considerations
- Identifying the location of the desired seal location on the bag even if it is somehow obscured.. - Picking the bagged product in such a way that the product doesn't fall out of the bag, even if the correct lifting point is at first unreachable. - Being able to detect contamination on the desired seal location.
Automation Considerations
- Being able to manipulate and orientate the bagged products at the required cadence. - Gripper options for products which are lose inside a bag. - Can the loading machine be directly interfaced with the vacuum machine to vary product throughput to improve seal reliability and bag/packaging qualities?
Suggesting R&D Demonstration and Development Approach
- The format of product presentation to this station will dictate the complexity of the solution. - Product presentation with reliable singulation, controlled orientation, easy identification and handling of desired sealing location coupled with basic primal identification and inspection will all contribute to successfully automating this operation. - Standalone plug and play installation would be more heavily reliant on rapid and robust primal and bag identification and inspection technology.
Processor automation concerns (Direct feedback from Processor interviews)
- Will I have to install a different type of Vacuum machine? - Can this process be automated at the speeds and accuracy required by machines that are effectively replacing FTEs one for one? - Can this system be integrated into my current process or does it require a complete overhaul of my pick and pack process?
Ultimate R&D Question(s) to be Answered
Can an automated system cost effectively identify, pick and place bagged products in preparation for vacuuming at the required cadence as part of an integrated or standalone offering?
How is this development used in an Advanced Automated Pick and Pack Operation
By itself, automating the bagged product placement for vacuuming will reduce FTEs and potentially improve seal reliability and final vacuumed bag qualities. As part of an integrated system, it would also continue the unbroken chain machine handling that guarantees accurate tracking of all products, minimising introduction of contaminants.
Preceding Research
- Unit Operation 1 required - Unit Operation 2-4 desirable

T (02) 8908 5500 F (02) 9436 0343 E ADMIN@AMPC.COM.AU WWW.AMPC.COM.AU



Pick-up and place on seal bar

Unit Operation 6: Bagged/Wrapped Primal Labelling (and inspection)

Objective

Label a primal post bagging/wrapping and either pre or post vacuum/shrinking with an identifier that can then be used by both a downstream label machine and carton packing system.

Human Activities / Actions Required

This is currently not a human activity per se, however may be required for a fully automated pick and pack process.

Product Considerations

Arguably the Unit Operation 1 – Primal Identification developments make this process considerably easier, although now with the primal contained in a bag or film then identification may become a little more difficult. This difficulty may increase after the vacuum and/or shrink process.

Processing Considerations

Speed. What to label (primal itself or the plastic bag/wrap)?

Automation Considerations

Lighting conditions. Does the primal take on a different shape post vacuum or shrink wrapping? If identification and labelling occurs before vacuum or shrink wrapping how does the identifying label appear post either one of these processes? Is it a label, ink jet, RFID or other label marking?

Suggesting R&D Demonstration and Development Approach

On the assumption that Unit Operation 1 R&D has been successfully completed, the R&D for Unit Operation 4 should focus on two aspects are follows:

1. What are the options for labelling a vacuum and shrink wrap package?
    a. Ink jet (Visible and non-visible ink)
    b. Laser engrave
    c. RFID
    d. Others
2. Are the options readable post the vacuum or shrink process if they occur prior to either of these processes?

Processor automation concerns (Direct feedback from Processor interviews)

How will this add value to the process?

Ultimate R&D Question(s) to be Answered

How can a primal in a bag identification process be developed for the purpose of downstream wrapped primal customer labelling (and subsequent automated primal carton packing).

How is this development used in an Advanced Automated Pick and Pack Operation

Currently the final wrapped or vacuum bagged primal has a label applied to it which (1) has been manually coded by an operator once they identify what the primal is and (2) manually place the label on the primal. This Unit Operation would place a machine readable identifier onto a wrapped or bagged primal (or raw primal) that a label printing machine (with weighing) could read and then produce the required label and a machine/robot then apply the label to the primal. This label would then be utilised by an automated primal cartooning solution.

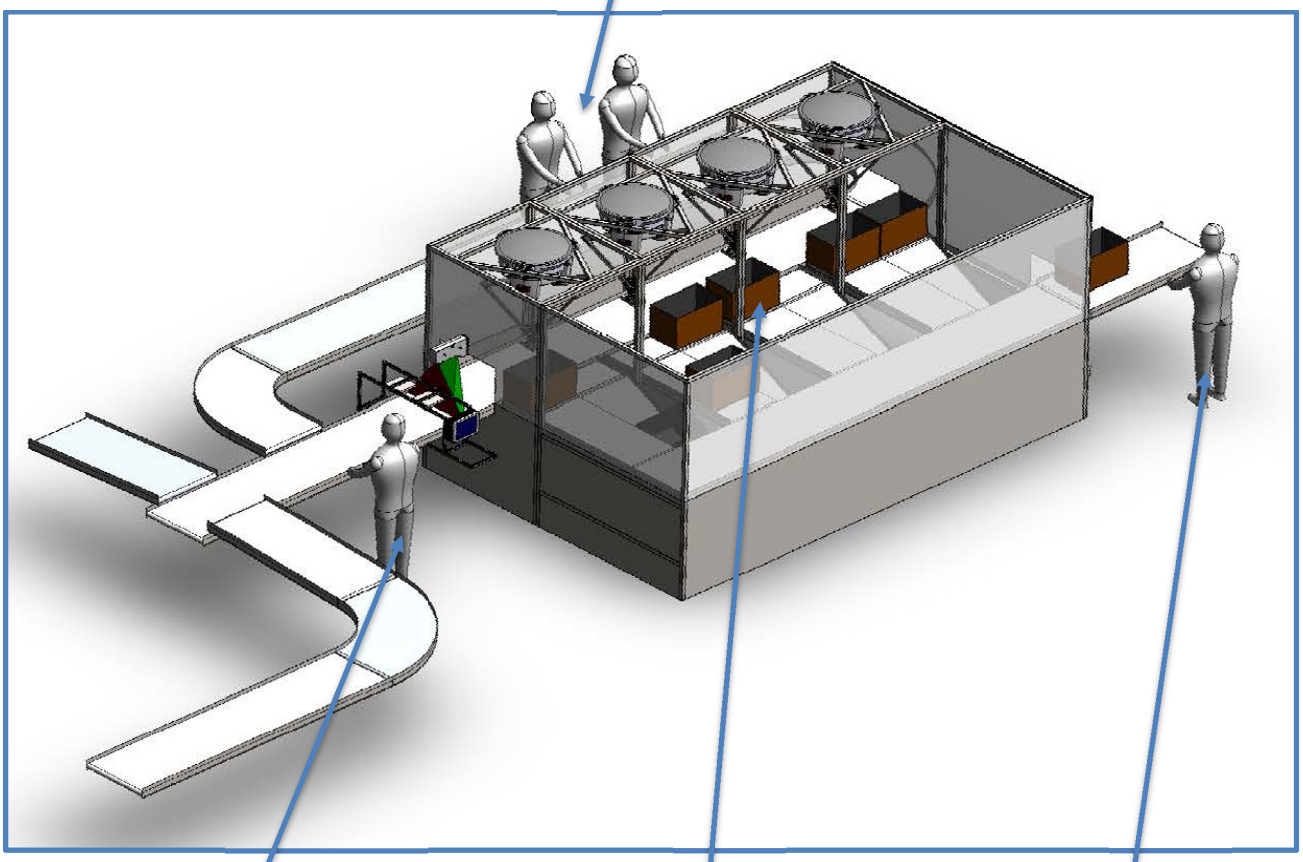
Preceding Research

- Unit Operation 1

Unit Operation 7: Wrapped/Bagged Primal Cartonisation

Objective
Place vacuum sealed and/or heat shrunk primals into cartons.
Human Activities / Actions Required
Operational staff monitor bagged/wrapped primals on a conveyor belt and as they arrive in various order combinations grasp a primal and place it into a carton with other like primals. Once a carton is stacked with the required number of primals the carton is progressed to the next unit operation.
Product Considerations
- Cannot damage plastic packaging or air tight seals. - Products are off shapes - Products may try to self-lock and snag on each other - Some product may be larger than other parts and need to be pack with an offsetting smaller primal part.
Processing Considerations
Operators will have multiple cartons being filled at any one time due to the mixed order nature of primals being conveyed to them.
Automation Considerations
How do you ensure a system can three dimensionally volume pack into a carton?
Suggesting R&D Demonstration and Development Approach
- Literature and Google search of other like applications in any other industry. Is there an automated jigsaw puzzle system anywhere? - Is the most likely successful approach packing directly into a carton or into a die/pre-former?
Processor automation concerns (Direct feedback from Processor interviews)
- You will never get a system to perform this task automatically. - How much space do we need? - How fast can it operate? - But I need more than one robot to replicate all of the staff in this area!
Ultimate R&D Question(s) to be Answered
Can you ever get an automated system to successfully stack odd shaped primals into a fixed volume carton? Maybe the solution is not pack into a die or pre-former and then load into a carton, or form a carton around the die/pre-former.
How is this development used in an Advanced Automated Pick and Pack Operation
This is the largest area of single operating staff function and a large cause of claims by customers of either wrong primal in carton or wrong number of primals in carton.
Preceding Research
- Arguably could be done without any however, Unit Operation 1 & 6 would increase the level of automation possible.

Manual pack into cartons 'harder' primals



Early development days Cryovac seal detection (Manual)

Auto pack into cartons 'easy win' primals

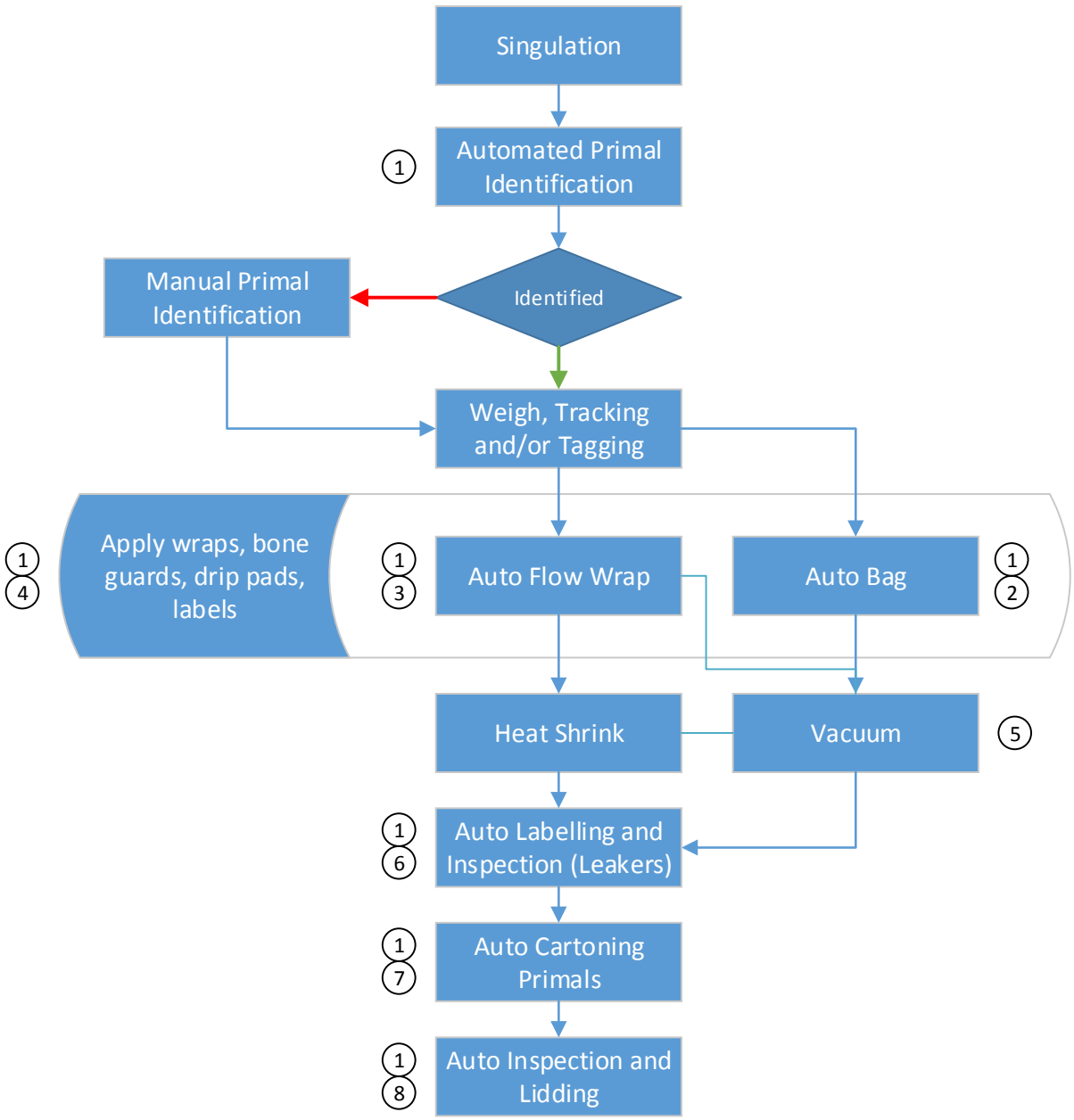
Early development days automated packing checking (Manual)

Unit Operation 8: Cartoned Final Inspection and Labelling

Objective
Undertake final weights and measures process and labelling of carton. Could include a primal ID and quantity inspection process as well.
Human Activities / Actions Required
Inspect the contents of the carton for the type of primal(s), ensure correct piece count, enter relevant information into check weight label making station and apply printed label to carton.
Product Considerations
Potentially cannot seel all primals with the naked eye if some primals are covering others (hence how to undertake a final piece count). Depending on he SKU configuration it may be difficult to differentiate between two (or more) very similar SKU offering and hence then ascertain the correct label to print.
Processing Considerations
Similar to above.
Automation Considerations
Similar to above
Suggesting R&D Demonstration and Development Approach
Stage 1 – Demonstrate an over the belt in-situ prototype system in a plant that has 100% success rate, or if not 100% rejects those that it knows it cannot accurate determine. Stage 2 – Link to the check weight label printing station. Stage 3 – Automatically print and apply label to carton.
Processor automation concerns (Direct feedback from Processor interviews)
What about when I have special carton orders? How do I train it for new orders?
Ultimate R&D Question(s) to be Answered
What is repaired in the in-situ station, or information from other Unit Operations for this Unit Operation to be automated?
How is this development used in an Advanced Automated Pick and Pack Operation
Eliminates the need for operational staff at the final check weigher and labelling stations.
Preceding Research
- Arguably could be done without any however, Unit Operation 1 & 6 would increase the level of automation possible.

Future Automated Pick and Pack (Concept)

The final report will provide a 3D schematic of a fully automated Pick and Pack solution on the assumption that the proposed R&D is successful. As part of this report a possible advanced automated primal pick and pack boning room of the future process flow is depicted in below.



Note: The numbers above identify where each unit operation development is to be applied. Unit operation #1 is required in multiple locations.

Research and Development Strategy

A parallel multifaceted approach is possible to developing the various unit operations required for the realisation of advanced boning room red meat pick and packing operations. The following is a strategic approach to developing automated pick and pack suite of solutions.

Table 12: Preliminary R&D Development steps, timeframes and budgets.

Stage	R&D Budget	Timeframe (months)
Unit Op. 1 → Ex-Boning and Slicing Wet Primal Identififcation		
Stage 1 – Detector determination	$100,000	6
Stage 2 – Permanent installation (learning/demonstration system)	$350,000	6-12
Unit Op. 2 → Wet Primal Bagging		
Stage 1 – Skunkworks Study (Machine vs Robot solution)	$ 50,000	3
Stage 2 – Build first prototype station and installed in a beef/lamb boning room	$550,000	9
Unit Op. 3 → Wet Primal Wrapping Placement		
Stage 1 – Skunkworks Study (Machine vs Robot solution and Gripper Types)	$ 50,000	3
Stage 2 – Vision Development	$230,000	6
Stage 3 – Build first prototype station and installed in a beef/lamb boning room	$620,000	9
Unit Op. 4 → Additional Material Application (i.e. Boneguard)		
Stage 1a – Insert Development Solution base design	$ 50,000	3
Stage 1b – Wrapped Solution (i.e. bone guard) Solution Base design	$150,000	3
Stage 2 – Build first two prototype station and installed in a boning room	$200,000	6
Unit Op. 5 → Loading Bagged Primals for Vaccuming		
Stage 1 – Skunkworks Study (Upstream at bag insertion station vs downstream at	$ 50,000	3
Stage 2 – Develop and install first prototype solution	$ 500,000	12
Unit Op. 6 → Bagged/Wrapped Primal Labelling (and Inspection)		
Stage 1 – Skunkworks Study (Can leakers be measured)	$ 25,000	3
Unit Op. 7 → Bagged/Wrapped Primal Cartonisation		
Stage 1 – Skunkworks Study (How to Pack and How to 3D volume determine)	$ 450,000	9
Stage 2 – Develop and install first prototype solution	$ 350,000	12
Unit Op. 8 → Cartoned Final Inspection and Labelling		
Stage 1 – Skunkworks Study (What should the limit be in automating this step?)	$ 40,000	3

Note: Final report will provide revised pricing and technical risk weighting.

Conclusion

The back end of a red meat boning room in the pick and pack area has been serviced well in the past with four main companies offering reliable pick and pack machines. For the entire process to be automated there are a number of Unit Operations that required a strategic research, development and demonstration strategy to be implemented. It is arguable that the current pick and pack commercial solution providers will not venture into these remaining areas and yet when ascertaining the cost of labour and customer complaints there is a considerable return on investment to captured if advanced automation can be achieved.

Based on the current Unit Operation concepts the current budget required for undertaking the first demonstration R&D development and indicative resulting recommended retail price for commercially developed solutions are depicted in Table 1.

Table 13: R&D and Commercial Costs.

	R&D (Demo)	RRP (Commercial)
U01	$ 450,000	$ 300,000
U02	$ 600,000	$ 250,000
U03	$ 900,000	$ 650,000
U04	$ 400,000	$ 250,000
U05	$ 550,000	$ 180,000
U06 & 7	$ 1,200,000	$ 700,000
U08	$ 800,000	$ 650,000
Total	**$ 4,900,000**	**$ 2,980,000**

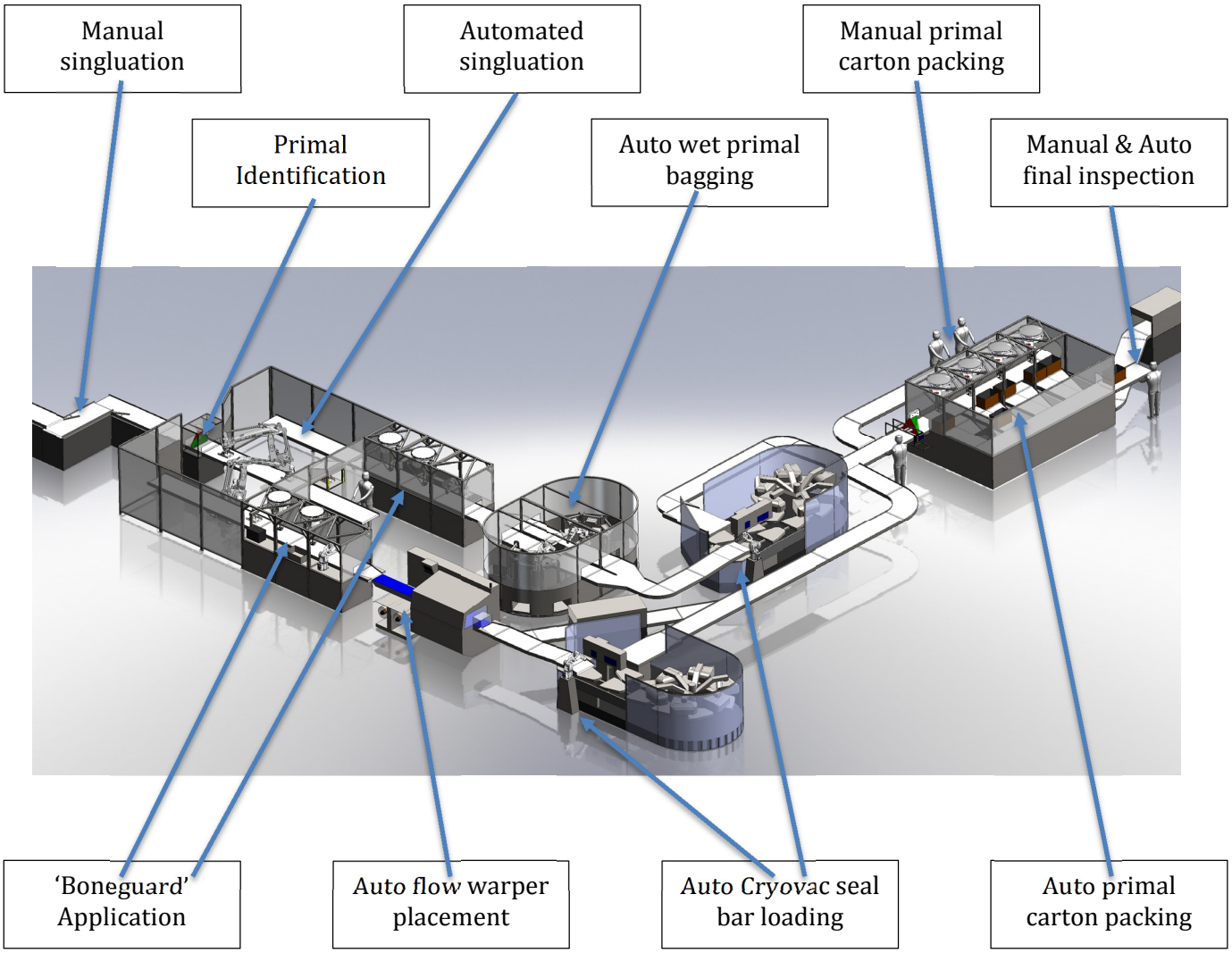
It is anticipated that the industry through its collective R&D funding mechanism could develop the R&D demonstrations of each unit operation. Successful demonstrations could then be further developed under processor plant initiated project funding models (where the host processor obtains the retention of the early development systems). Finally those that wait would be able to obtain the commercial solutions at the above indicative recommended retail prices. In some cases multiple units may be required to match processing capacity.

On the assumption that at least seventy percent of the labour could be removed from the pick and pack area, greater than twenty (20) FTE's could be placed elsewhere in the business resulting in $2.8 million of investment available based on a two(2) year payback for a processor, operating a single shift. Larger

processing companies may need to purchase multiple unit operations, however these larger processing companies also typically operate dual shifts and hence increases the labour investment savings.

It is not plausible that a meat processing company (or commercial solution provide) in its own right will undertake these developments as the early research required is at the blue sky end of the research and development spectrum.

The automated Pick and Pack area of a boning room could be envisaged to look like the following.



Appendix A – Existing Equipment (Red Meat Boning Rooms)

The following have been selected because they are either currently used, or could be used, within the back end of a typical boning room Pick and Pack area as defined by this project. Packing systems that pack the same product (i.e. hamburger patties) have purposefully been excluded from the list due to their current limitations. These omitted solutions can be found in Appendix B. Non-mainstream brands have been purposefully omitted (i.e. perceived Chinese copies of others knowhow).

Search Terms (first 20 pages returned reviewed)

Search Term		Search Term
• meat wrapping machine		• automated meat packing
• automated meat picking		• automated meat handling
• meat packing		• meat handling
• automated meat processing		• robotic meat processing
• robotic meat packing		• robotic cartoning packing
• robotic meat cutting		• robotic meat slicing
• automated meat slicing		• packing unusual shapes
• automated meat primal identification		• beef automation

Manual Bagging and Wrapping Machines

Companies

- Ulma (http://www.ulmapackaging.com/)
- Cryovac (http://www.cryovac.com/AP/EN/Default.aspx)
- GNA (http://www.gnasrl.com/)
- SuperVac (http://www.supervac.at/en/applications/meat)
- Baumann (http://baumann-industries.com/)

Examples

- http://www.ulmapackaging.com/packaging-machines/flow-pack-hffs/fv-55
- http://www.ulmapackaging.com/packaging-machines/flow-pack-hffs/fm-300
- http://www.ulmapackaging.com/packaging-machines/flow-pack-hffs/fv-45
- http://www.ulmapackaging.com/packaging-machines/thermoforming-and-blister/optima
- http://www.cryovac.com/AP/EN/food-packaging-equipment/8600-rotatry-vacuum.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/8800e-bag-loader-rotary-vacuum.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/8490-vertical-rotary-vacuum-bag.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/bag-loaders-taped.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/bag-loader-bl101-taped.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/bag-loader-bl125.aspx
- http://www.cryovac.com/AP/EN/food-packaging-equipment/blr-roboloader.aspx
- http://www.supervac.at/en/products/beltmachines/gk_852_853_862_863_b
- http://www.supervac.at/en/products/bag_opening_machine/bg_450

Examples (Videos)

- https://www.youtube.com/watch?v=2P9eL7bnV9Y (GNA)
- https://www.youtube.com/watch?v=I-bgE0k3xHc (SuperVac)
- https://www.youtube.com/watch?v=mUc6pte_Zns (Cryovac)
- https://www.youtube.com/watch?v=igiY9M4euXs (Cryovac)

Appendix B – Existing Equipment (Case Ready Meat Rooms)

Note: the following have been selected because they are either currently used in 'case ready' rooms where they are typically handling the same piece of meat (i.e. hamburger patties) and as such are limited in their current application to red meat boning room Pick and Pack solutions. Although with additional enablers provide a platform and/or discussion point of possible solutions for automating Boning Room Pick and Pack needs.

Bagging and Wrapping

Companies

- Ulma/Cryovac (http://www.ulmapackaging.com/) (Using Others' 'flexpicker concept)
- Marel (with AEW Delford)
- Gruppo Fabbri (http://www.gruppofabbri.com/en)
- Applied Robotics
- JLS Automation
- Kuka
- Fanuc
- ABB
- GEA

Examples

- http://www.ulmapackaging.com/packaging-machines/integral-solution/ulma-robots
- http://www.ulmapackaging.com/packaging-machines/integral-solution/automatic-loading-to-flow-pack
- http://www.ulmapackaging.com/packaging-machines/integral-solution/automation-with-carton-case

Videos

- https://www.youtube.com/watch?v=_X2baoH_7M0 (Marel)
- https://www.youtube.com/watch?v=wtCCOkq-wRw (Marel)
- https://www.youtube.com/watch?v=y_fqoFoI1ss (GruppoFabbri)
- https://www.youtube.com/watch?v=qfUR4jz6fFY (Applied Robotics)
- https://www.youtube.com/watch?v=aPTd8XDZOEk (ABB)
- https://www.youtube.com/watch?v=a7XzTTEaiuU (JLS Automation)
- https://www.youtube.com/watch?v=zWlgSfSxvJo (GEA)
- https://www.youtube.com/watch?v=Xc8lTu5sZj0 (Applied Robotics)
- https://www.youtube.com/watch?v=7H_lFe0NNr4 (Applied Robotics)
-

Appendix C – Existing Equipment (Other Industries)

Note: the following have been selected because they are in use in other industries and conceptually there are aspects of their design which is worth consideration. Other industries include:

Bagging and Wrapping

Companies

- http://www.cryovac.com/AP/EN/Default.aspx (Cryovac)

Examples (Videos)

- https://www.youtube.com/watch?v=sg1mzJxOh8E (Cryovac)

Appendix D – R&D Concepts Uncovered

Inkjet Printing

Videos

- https://www.youtube.com/watch?v=gcZy2VPRrCw (Douglas Wohlford)
- https://www.youtube.com/watch?v=KRYOgf25le4 (via an overwrap) (ID Technology)

Bagging/Wrap Insertion

Videos

- https://www.youtube.com/watch?v=7DAO9Hp65SI (JANTZ)
- https://www.youtube.com/watch?v=3CQQDBSbS3o (IMA)
- https://www.youtube.com/watch?v=YxSjndwnUsA (CVP Systems)